

# **The Global Exploration Roadmap**

**International Space Exploration Coordination Group (ISECG)**

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***GER Day, ELS, Frascati, May 15, 2015***

# About ISECG



## ◆ ISECG is a non-political agency coordination forum of 14 space agencies

- Website: [www.globalspaceexploration.org](http://www.globalspaceexploration.org)

## ◆ Work collectively in a non-binding, consensus-driven manner towards advancing the Global Exploration Strategy

- Provide a forum for discussion of interests, objectives and plans
- Provide a forum for development of conceptual products
- Enable the multilateral or bilateral partnerships necessary to accomplish complex exploration missions
- Promote interest and engagement in space exploration among citizens and society

## ◆ ISECG operating principles

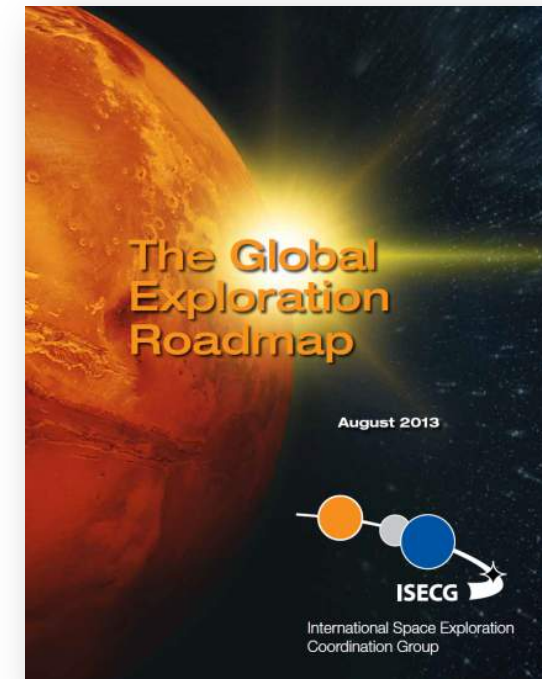
- Open and inclusive
- Flexible and evolutionary
- Effective
- Mutual interest



# About the Global Exploration Roadmap



- ◆ **The GER is a human space exploration roadmap, recognizing the criticality of increasing synergies with robotic missions while demonstrating the unique and important role humans play in realizing societal benefits**
- ◆ **The non-binding document reflects a framework for agency exploration discussions on:**
  - Common goals and objectives
  - Long-range mission scenarios and architectures
  - Opportunities for near-term coordination and cooperation on preparatory activities
- ◆ **Since release of updated GER in August 2013, participating agencies have continued discussions and joint work in several areas which are of mutual interest**
  - China (CNSA) has joined the dialog
  - Increase understanding of design reference missions for early mission themes
- ◆ **Highlighting opportunities for the science community with a dedicated Science White Paper and within the GER itself is a priority**



# The Global Exploration Roadmap



2013

2020

2030

## International Space Station

General Research and Exploration  
Preparatory Activities

Note: ISS partner agencies have agreed to use the ISS until at least 2020.

Commercial or Government Low-Earth Orbit Platforms and Missions

## Robotic Missions to Discover and Prepare



Mars Sample  
Return and  
Precursor  
Opportunities

## Human Missions Beyond Low-Earth Orbit



Explore Near-Earth Asteroid

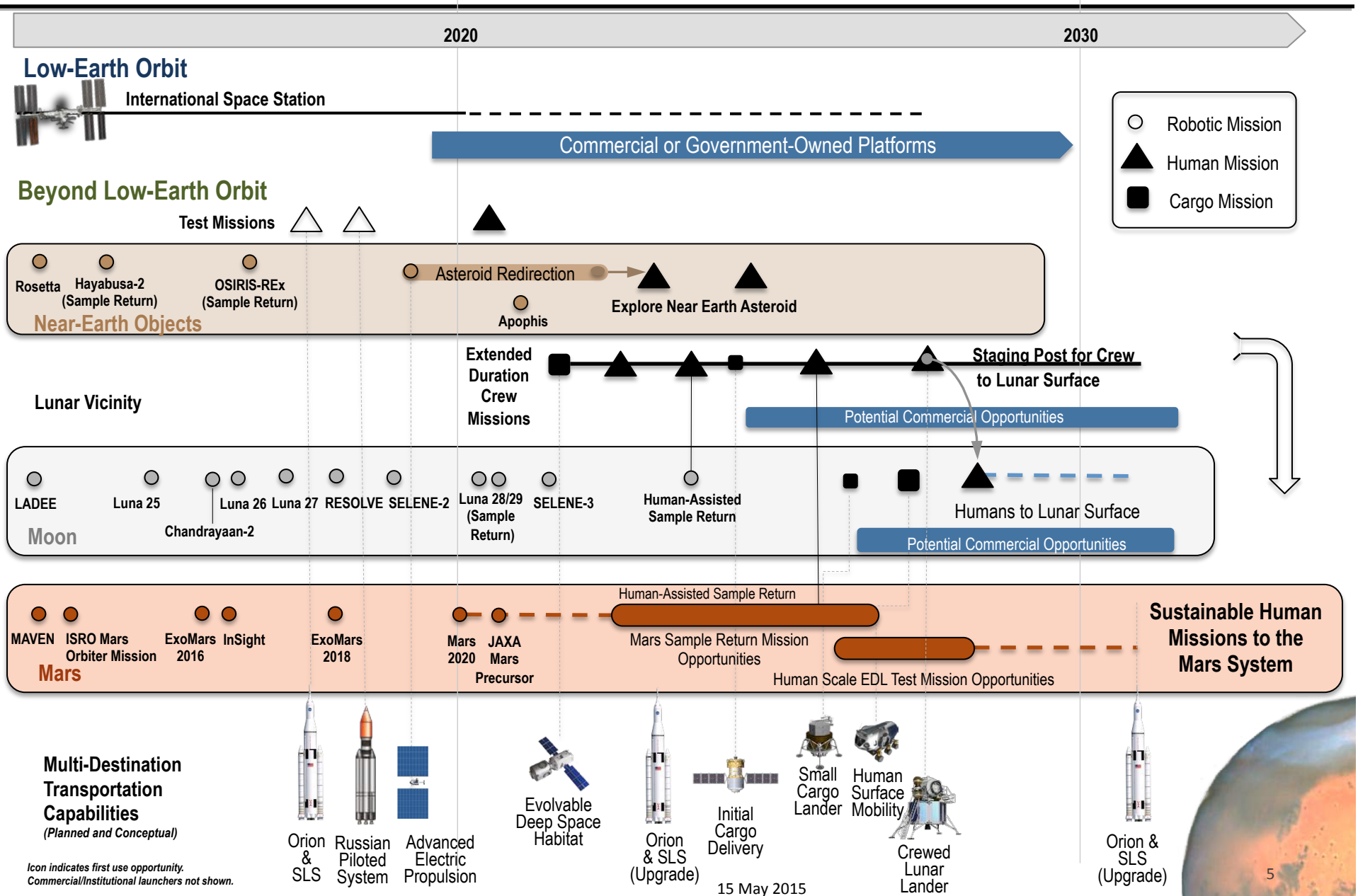
Extended Duration Crew  
Missions

Humans to  
Lunar Surface

Missions to  
Deep Space and  
Mars System

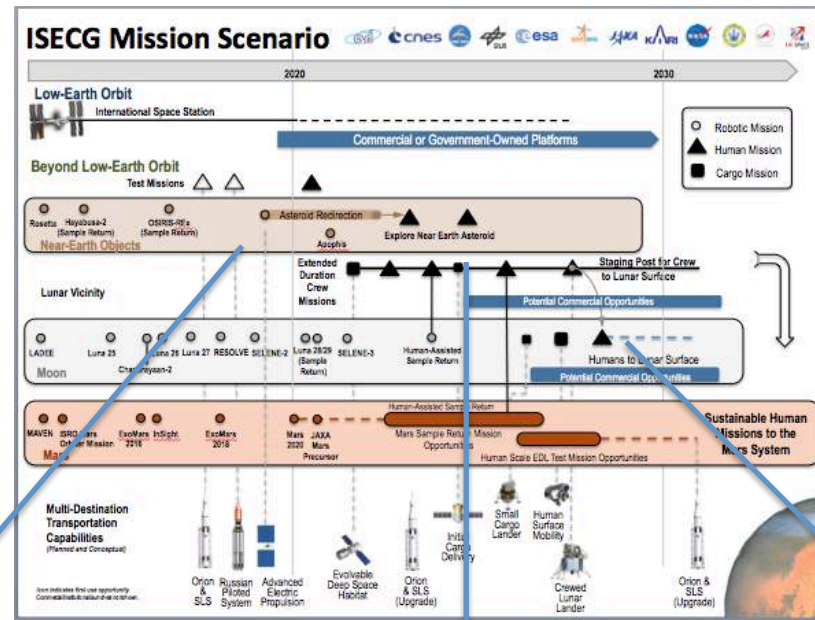
Sustainable  
Human Missions  
to Mars Surface

# GER Mission Scenario





# GER Mission Themes



### Exploration of a Near Earth Asteroid

Human exploration of an asteroid which has been captured and redirected to lunar vicinity

**Enabling Capabilities**

- NASA's SLS and Orion
- Advanced Electric Propulsion
- Extra Vehicular Activity

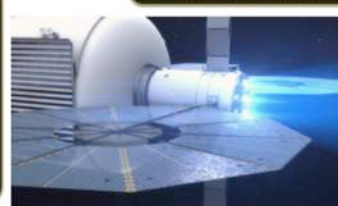
**Contributions to Mars Mission Readiness**

Demonstration of the following core capabilities:

- Space Launch System and Orion
- 30-50kW Solar Electric Propulsion System
- Spacewalk, rendezvous, proximity operations, docking or grapple, deep space navigation and communications.

**Mission Activities**

- Characterize the composition of the asteroid
- Identify any resources and assess their potential for extraction
- Apply human evaluation capabilities to select samples for return to Earth laboratories
- Demonstrating sample acquisition, caching, storage operations, and crew transfer operations for future human-assisted sample return mission.



### Extended Duration Crew Missions

Visits to an evolvable Deep Space Habitat in the lunar vicinity

**Enabling Capabilities**

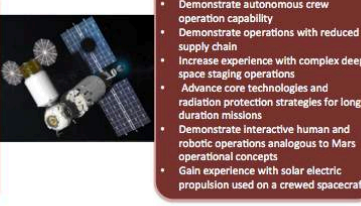
- NASA's SLS and Orion
- Russian Piloted System
- Evolvable Deep Space Habitat
- Cargo Delivery

**Mission Activities**

- Advancing deep space human space flight operations and techniques, including staging operations
- Conducting high priority science benefiting from human presence, including human-assisted lunar sample return.
- Testing technologies and subsystems benefitting from the deep space environment
- Characterizing human health and performance in a deep space environment

**Contributions to Mars Mission Readiness**

- Demonstrate deep space exploration capabilities such as SLS, Orion, advanced Russian crew transportation capabilities and life support systems, achieving an acceptable level of risk prior to travel to destinations away from the relative safety of Earth's orbit
- Demonstrate autonomous crew operation capability
- Demonstrate operations with reduced supply chain
- Increase experience with complex deep space staging operations
- Advance core technologies and radiation protection strategies for long duration missions
- Demonstrate interactive human and robotic operations analogous to Mars operational concepts
- Gain experience with solar electric propulsion used on a crewed spacecraft



### Humans to the Lunar Surface

Using evolvable Deep Space Habitat as staging post

**Enabling Capabilities**


- NASA's SLS and Orion
- Russian Piloted System
- Evolvable Deep Space Habitat
- Lunar Lander
- Cargo Delivery

**Mission Activities**

- Test advanced surface power technologies
- Address high priority objectives of the science community which benefit from human surface presence
- Characterize human health and performance in a partial gravity environment
- Demonstrate long distance mobility concepts
- Explore concepts for human-robotic partnership in planetary surface exploration
- Utilize precision landing technologies demonstrated on robotic missions
- Explore landing sites of interest for extended durations

**Contributions to Mars Mission Readiness**

- Demonstrate staging operations with an Earth-return vehicle
- Demonstrate extended crew mobility and habitation systems
- Demonstrate advanced power systems
- Characterize human health and performance, combining deep space and partial gravity environment exposure
- Demonstrate operations concepts and enhanced crew autonomy for surface exploration
- Potentially provide the opportunity for advancing concepts related to the use of local resources



# GER Preparatory Activities

## Use of the ISS for Exploration

Credit: NASA

## Robotic Missions

Credit: NASA

Credit: AMASE/K.O. Storvik

## Analogues to Simulate Exploration Destinations

## New Space Systems & Infrastructure

Credit: ESA/NASA

Credit: DLR

## Advanced Technologies

## Health and Human Performance Risks

Credit: NASA

## ◆ Long Range Exploration Strategy

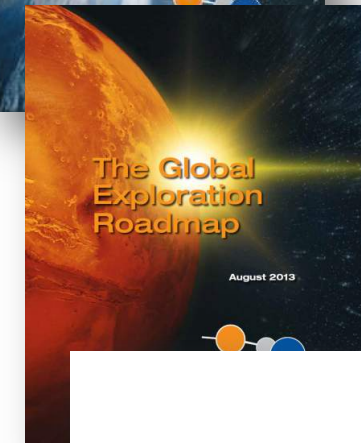
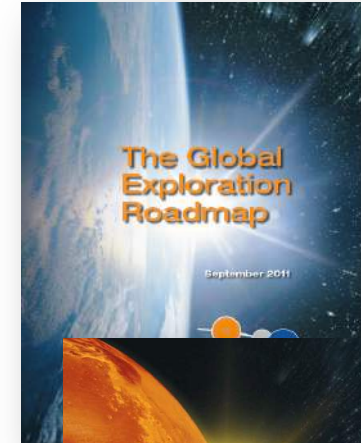
- Advance definition of early mission concepts (by individual agencies or ISECG)
  - NASA Asteroid Redirect Mission
  - Extended Duration Missions
  - Lunar Surface missions
- Advance mission concepts which build on human-robotic exploration partnership
  - Human-Assisted Sample Return
  - Coordinated Assessment of Polar Volatiles
- Standards to promote interoperability

## ◆ Opportunities for Coordination and Cooperation

- Advanced technologies



- ◆ ISECG is committed to engage in a global roadmapping process with regular iterations of GER to strengthen the global efforts to realize human and robotic missions
- ◆ Next update envisioned to include:
  - Updated view of planned missions
  - Further elaboration of concepts for early mission themes
    - Lunar vicinity and lunar surface
  - Innovative ideas received from global stakeholder engagement
- ◆ Next update expected mid-2016
  - Science White Paper will be a companion document



**GER 3**